



Usability Testing and Analysis Facility (UTAF)

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UTAF Overview



- **One of the Space Human Factors Laboratories in the Habitability and Human Factors Branch (SF3) at NASA Johnson Space Center**
- **Primary focus: Human factors evaluation and usability testing of crew / vehicle interfaces**
- **Staff**
 - **NASA Technical Monitor: Doug Wong**
 - **Contractor Lead: Kritina Holden**
 - **Current number of staff members: 10**



UTAF Expertise and Capabilities



- **Unique mix of backgrounds**
 - Human factors and usability
 - Engineering psychology
 - Human-computer interaction
 - Industrial engineering
 - Biomedical engineering
 - Visual and auditory perception
 - Attention and memory
 - Learning and decision making
 - Aviation psychology





UTAF

Processes / Methodologies



Human Factors

- Human-Centered Design
- Human-system integration requirements development and interpretation
- Observational/Ethnographic studies
- Task analysis and function allocation
- Scenario and script development
- Information architecture and interaction design
- Human factors assessment
- Heuristic evaluation
- Cognitive walkthrough
- User testing/Human-in-the-loop testing
- User interface design and testing (e.g., websites, software displays, hardware panels and controls, and procedures)
- Applied human factors research
- Human performance modeling
- Error analysis
- Link analysis
- Workload and situational awareness

General

- Questionnaire and survey design
- Research methods and experimental design
- Parametric, non-parametric, and multivariate statistical analysis
- Proposal development
- Technical writing



UTAF Equipment



- **UTAF consists of:**
 - Isolated subject and control rooms
 - Video recording, editing, and analysis equipment
 - Eye- and head-trackers
 - Hardware and software tools
 - Flight-like computers
 - User interface prototyping tools
 - Specialized statistical analysis software
 - Survey software
 - User testing and recording tools with remote site testing capability
 - Multi-media, web-based, and statistical tools
- **Access to analog environments:**
 - Reduced gravity aircraft (C9, zero-g plane)
 - ISS, Shuttle, Orion mock-ups
 - Neutral Buoyancy Laboratory
 - Testbed Facilities (chamber, NEEMO)



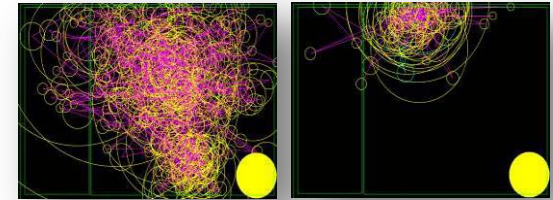


Key Functions and Products



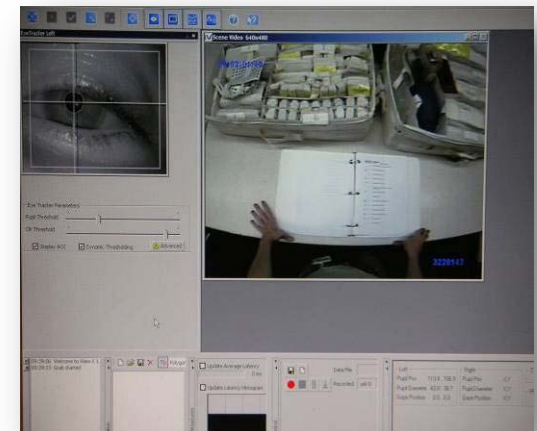
- **Key Functions**

- Human factors consultant/team member
- Advocate for crew
- Facilitate Human-Centered Design
- Evaluate user interface designs through heuristic and established usability evaluation methods
- Space human factors research



- **Products**

- Human engineering requirements
- User interface development
- Displays and controls
- Workstation systems
- Work environments
- Task procedures

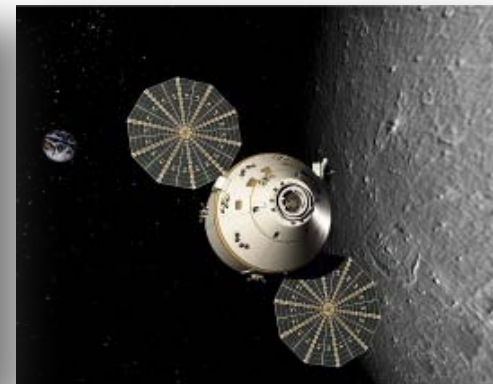




UTAF Program and Research Support

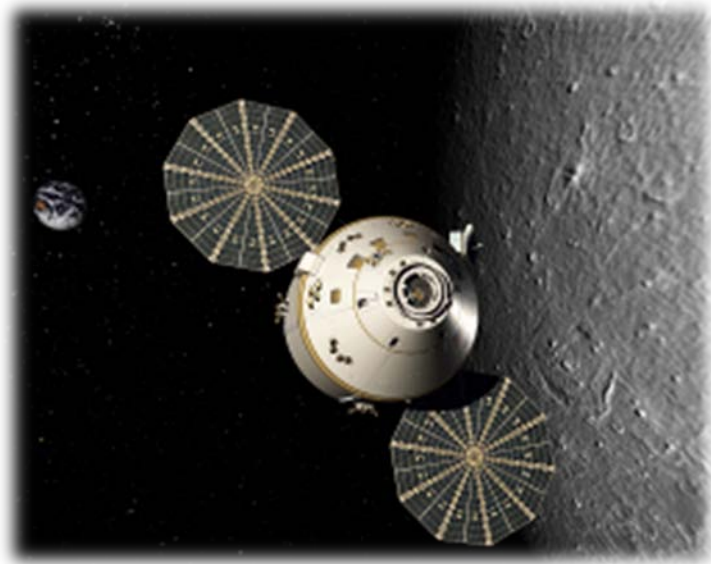


- **Human factors support to major space programs**
 - **Constellation Program (CxP)**
 - Orion Crew Exploration Vehicle, EVA, Altair, and Lunar Habitats
 - **International Space Station**
 - **Commercial Orbital Transportation Services (COTS)**
- **Space human factors research**
 - **Space Human Factors Engineering Directed Research funded by the Human Research Program**
 - Information Presentation ,Training, Usability, Human-Robot Interaction
 - **Research projects with external businesses and universities**





CxP Orion Support





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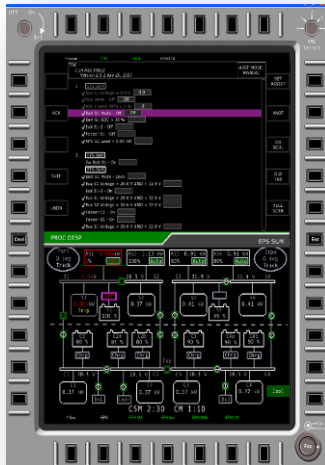


Orion Displays and Controls



Displays

- Conduct hierarchical task analysis
- Support ConOps development
- Support display format standards development
- Develop display evaluation process
- Conduct crew evaluations of display prototypes
- Evaluate electronic procedures
- Owner of workload and usability requirements



Controls

- Conduct crew evaluations of cursor control device concepts



- Test unpressurized and pressurized glovebox usability with representative task scenarios / displays



- Hand controller evaluations



- Edge key and panel ops evaluations
- Effects of vibration on use of controls



CxP EVA Support





EVA Integrated Suit Test



Exploration Task Analyses



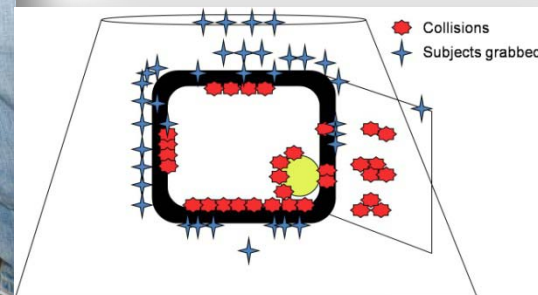
Simulated geology tasks – shoveling rocks

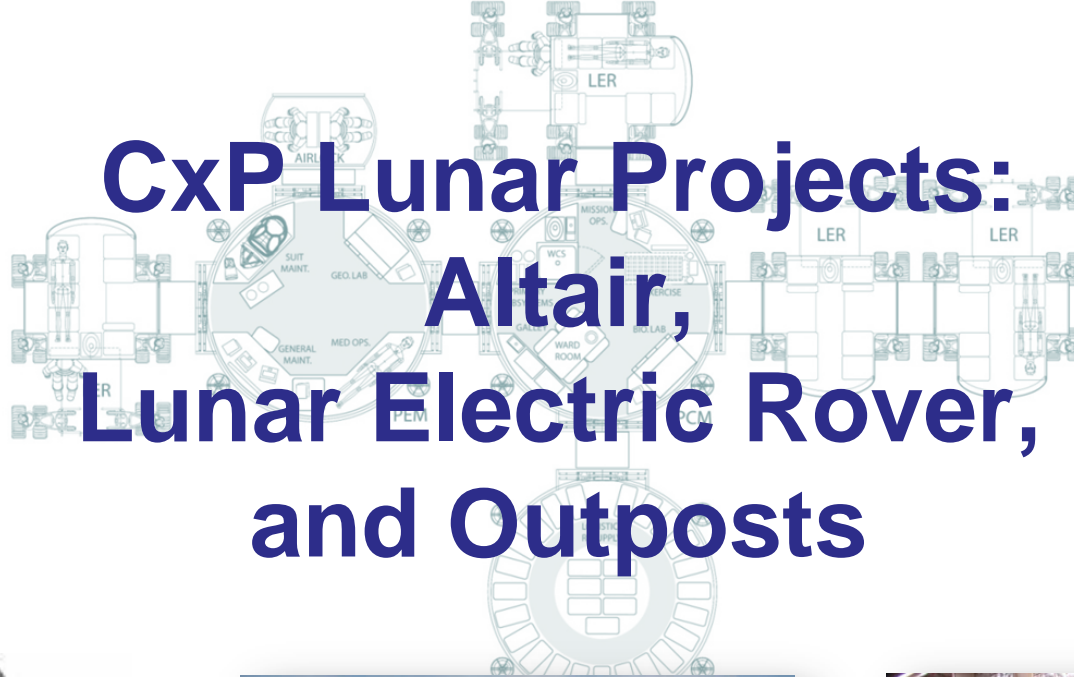


EVA hammering task



1-g Emergency Hatch Egress





CxP Lunar Projects: Altair, Lunar Electric Rover, and Outposts





Altair Lunar Lander



- **Evaluate habitable volume, mission operations, overall design**
 - Suited and unsuited groups performing functional tasks (eating and sleeping, medical events, maintenance, etc.)
 - This aids in studying the crew's net habitable volume (NHV)





UTAF Support for Space Exploration Vehicle (SEV)



- HF plays a major role in designing the vehicle's nose, window placement, and interior functionality
- HF engineers participated in two DRATS habitability studies (3 and 14 days) examining areas like driving, displays & controls, visibility, EVA, daily operations, sleep, and exercise, etc.
- Using lessons learned from the two field tests, some redesign of visibility, software, cabin, storage, and suit ports has been implement to improve the crew's efficiency
- A GEN 2 SEV is in the design phase today

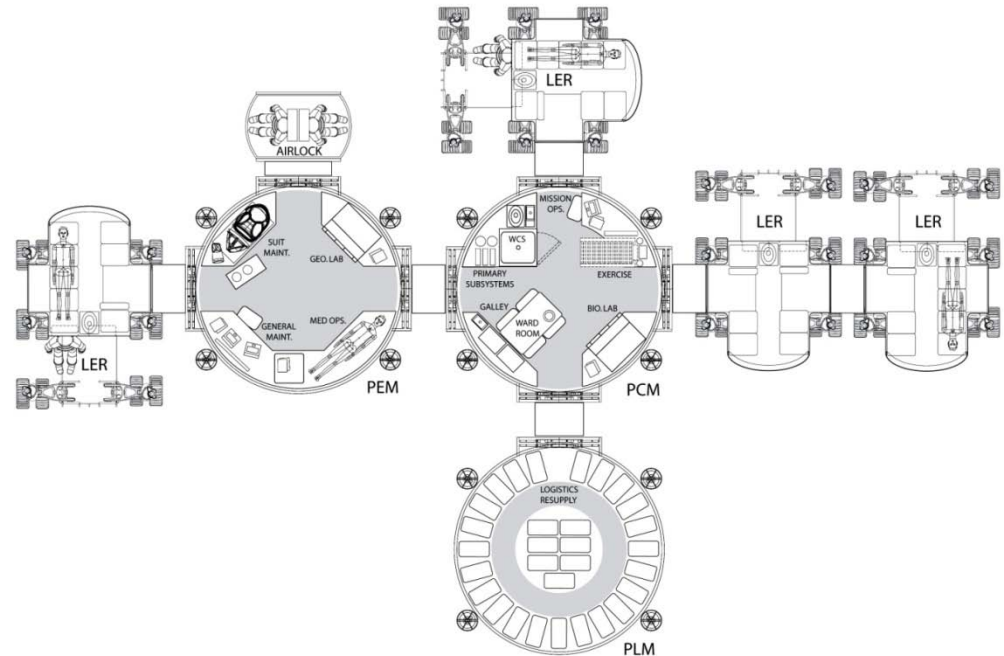
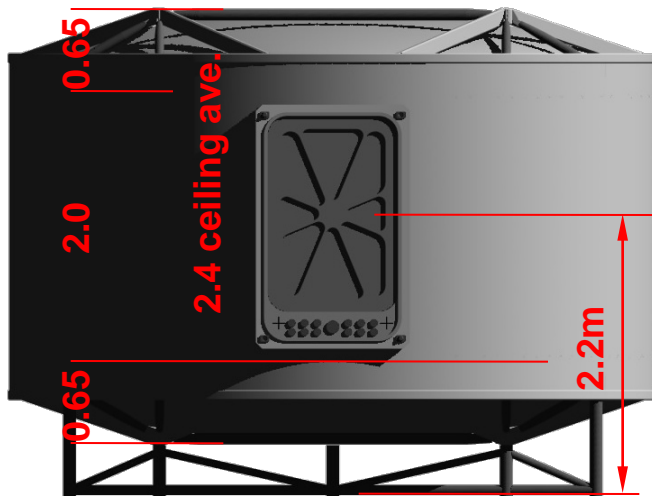




UTAF Support for the Habitat Demonstration Unit (HDU)



- NASA's Lunar Surface Systems team is constructing the Habitat Demonstration Unit (HDU) to test crew habitability, subsystems, and procedures for lunar missions
- UTAf will support displays and controls development for the HDU as well as testing the NHV





Commercial Orbital Transportation Services (COTS)



Orbital

SPACEX





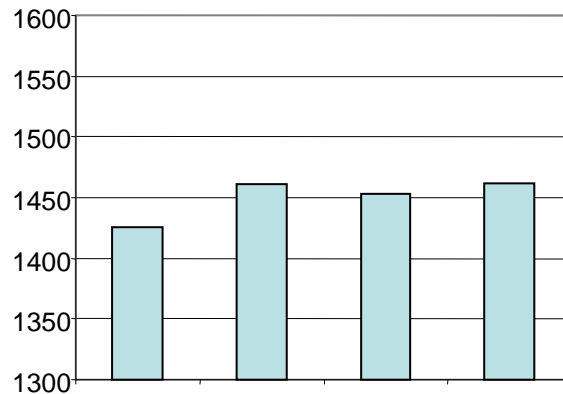
Commercial Human Systems Integration Requirements Development



- **Development of the Commercial Human Systems Integration Requirements (CHSIR) for the COTS program**
 - **Leveraging CxP experience**
 - **Offering Subject Matter Experts (SMEs) in a number of Human Factors areas**
 - **Crew hardware and software interface design**
 - **Displays and controls**
 - **Electronic procedures**
 - **Net habitable volume**
 - **Usability and workload**



Human Research Program – Space Human Factors Engineering

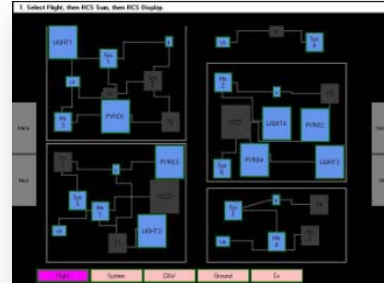




Information Presentation Research



- **Displays**
 - Label alignment
 - Alarms
 - Multi-monitor interaction
 - Color Coding
 - Head Mounted Displays
- **Controls**
 - Cursor control device design
 - Cursor movement
 - Dual-task performance
 - Pressurized gloved operations
- **Vibration**
 - Readability under vibration
 - Use of cursor control devices under vibration



hub	on
record	left
nominal force	right
rechargeable	54
control panel	43
accelerator	23
pharmaceutical	67
buffer	top
data	open
extravehicular	down
group	up
supplemental	21
cabin	68
heat exchanger	79
pump module	35
cooling unit	in





Cursor Control Device Studies

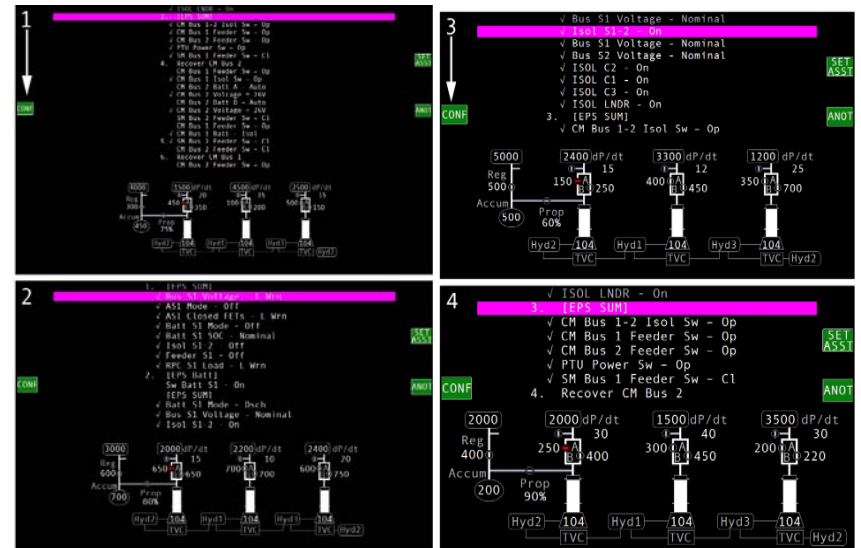




- Objectives
 - Provide operational data to supplement ground-based studies aimed at understanding human performance limits under vibration
 - Provide crew readability data to be used in conjunction with DTO 695, which measures Shuttle seat vibration
 - Assess readability of different font sizes under vibration, using Orion-like display formats
- Task
 - During each ascent phase, scan the placards and determine the smallest readable display

[illegible]

Mid-deck placards and response card



Placard showing 4 displays/font sizes



Training Research



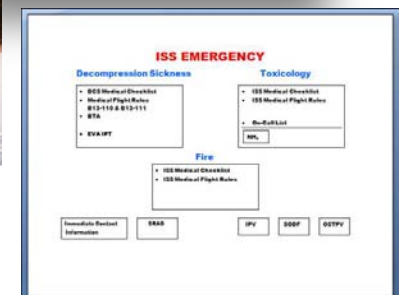
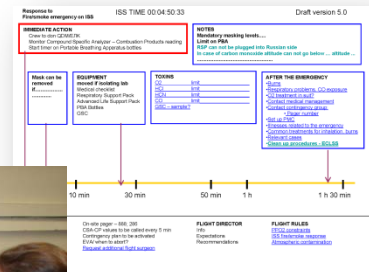
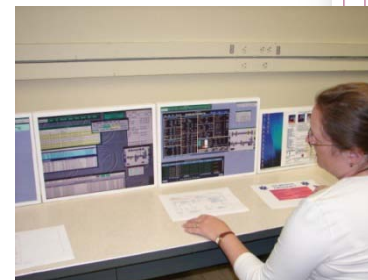
Research focuses on space medical operations training for both crewmembers and ground support

Feasibility of Crew Medical Officer (CMO) just-in-time (JIT) training & procedures tools evaluations

- Head mounted display
- Wrist mounted displays
- Combined auditory instructions with graphics displays

Conceptual development of flight surgeon performance support tool for responses to vehicle emergencies (Fire, Decompression, and Toxic Exposure)

- Flight surgeon formative evaluation
- Paper prototype development
- Electronic prototype development





Usability Research



- **Areas of Focus**
 - Usability factors: efficiency, effectiveness, and satisfaction
 - Errors: metrics, methods, and requirements
 - Consistency scale development and testing
 - Legibility methods and requirements
 - Maneuverability Assessment Scale development and testing

